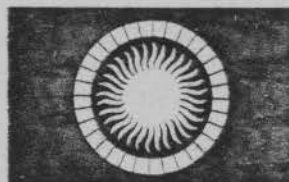
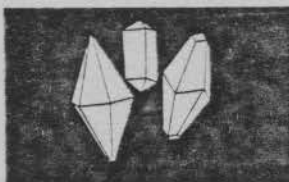
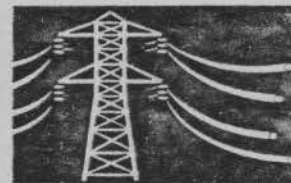


# **Policy Options for MISSOURI COAL**



**GOVERNOR'S ADVISORY COUNCIL ON MISSOURI COAL**  
**Missouri Department of Natural Resources**

## GOVERNOR'S ADVISORY COUNCIL ON MISSOURI COAL

1980-81

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In late 1979, the Governor's Advisory Council on Missouri Coal was established by Executive Order to "(1) Advise the Governor regarding the most appropriate methods for utilizing Missouri coal in an environmentally sound and economically feasible manner; (2) Make recommendations to the Governor on legislation which would facilitate the production and use of Missouri coal; (3) Advise the Governor on federal programs and projects which the State of Missouri may seek in order to demonstrate the uses of Missouri coal; (4) Recommend programs to the Department of Natural Resources that will facilitate the review of environmental procedures for plants that desire to use coal and will assist industries in complying with the procedures and policies for converting to or constructing new plants that will use coal as a primary fuel source; and (5) Advise the Governor as to solutions for environmental problems arising from coal usage.

The Council is assigned to the Department of Natural Resources, for administrative purposes. The Council structure and function was extended by Governor Bond to June 30, 1981.

<sup>1</sup> replaces Theodore J. Planje, deceased (7/14/80)

<sup>2</sup> replaced Robert Schreiber, June 1980

<sup>3</sup> replaced Jay Abbott, January 1981

<sup>4</sup> replaced Jack Keane, January 1981

# **Policy Options for MISSOURI COAL**

June 1981

ANNUAL REPORT

GOVERNOR'S ADVISORY COUNCIL ON MISSOURI COAL  
Missouri Department of Natural Resources



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## PREFACE

This report concentrates on problems that currently appear to affect Missouri coal production and utilization most critically. The Policy Options suggested as appropriate response(s) to the "issues" are individually incapable of significant mitigation of problems concerning Missouri coal. Collectively, however, they offer the hope of improvement in an extended period of difficulty. For effective results, most options defined require specific additional and, in some cases, new direction of effort by state government.

Although the nation currently is in an economic slump, the coal industry appears to have a strong growth position nationally and internationally as coal is increasingly emphasized as a major energy source. Missouri coal development can share in this growth if its inherent advantages are known and its weaknesses appropriately addressed. Recommendations in this report are based on opinions concerning coal-resource development and utilization expressed by members of the Governor's Advisory Council on Missouri Coal (see inside front cover). The Advisory Council, formed in December 1979, essentially continues a similar group that served in 1975-1976, and comprises representatives of the coal mining industry; the electric utility industry; organized labor; state-government resource, development, and regulatory agencies; a nationally recognized

research organization; the academic sector; and the public. The Advisory Council commends this report and its recommendations to the attention of Missouri Governor Christopher S. Bond, to Missouri Legislature and Executive Departments, to the Missouri Congressional Delegation, and to the public and private sectors.

In addition to considering coal-resource development issues, the Advisory Council submitted numerous informational and advisory memoranda, and budgetary and legislative recommendations to the Office of the Governor during calendar 1980. An annotated listing of those recommendations is included in this report as Appendix I. Several of the legislative recommendations are currently under consideration by the 81st General Assembly.

Finally, for their support in developing this report, it is essential to recognize the assistance and input of Charles E. Robertson (DNR-Geological Survey), Stephen D. Hincey and Steven T. Beleck (DNR-Energy), Beth Rice (DNR-Air Quality), Larry J. Shannon (Midwest Research Institute), and to Earl Cannon and other Missouri Division of Community and Economic Development staff. It is a pleasure to acknowledge the assistance of Robert H. Hansman, Editor, DNR, Division of Geology and Land Survey.

Wallace B. Howe, Chairman

Date: 15 May, 1981

## EXECUTIVE SUMMARY

Coal production has been a significant factor in the economy of Missouri for decades. Recently the nation's concern for its energy supply, which became pervasive in the decade of the 70's, has focused the attention of Missourians on the fact that the state has a large source of energy in its coal deposits and has raised questions about how these deposits could better contribute to the state's economy and better insure that Missouri has an adequate energy supply. In this report, the Governor's Advisory Council on Missouri Coal has attempted to summarize the status of the coal industry in Missouri, to identify the principal factors constraining the production and utilization of Missouri coal, and to recommend appropriate policy positions for state government to consider. These recommendations are designed to permit Missouri to take the best advantage of its coal deposits.

One of the few things most energy experts agree on is that a major increase in coal use is essential if the nation is to meet its energy needs between now and the end of the century. However, up to the present time, coal production and use in Missouri and throughout the nation have been constrained by economics, unresolved policy issues, and uncertainties concerning environmental regulations.

### COAL RESOURCES

Missouri's coal resources are an important asset to the state, and that importance should increase as the nation's reliance on coal as a primary energy source increases. Missouri currently produces only 25 percent of the coal it consumes, yet it has *recoverable measured reserves* of 875 million tons, sufficient to provide its expected needs for many years. The reserve base is adequate to support coal mining at a rate of nearly 29 million tons per year, — approximately five (5) times the current level of production. In view of Missouri's *estimated resource base* of 48 billion tons of coal, it seems

likely that the State could supply its coal needs for several hundred years. However, the extent to which these resources will be developed depends upon a number of complex factors, including the economics of competing energy sources, the effect of environmental regulations, the successful development of newly emerging technology, the effort expended in determining additional coal reserves, and the state's posture in dealing with these issues.

### STATUS OF THE COAL MINING INDUSTRY

There are two types of coal mining operations in Missouri. In 1979, 77 percent of the coal produced in the state was mined by three companies under "life of mine" contracts. These operations are relatively large and well financed, but their long-term contracts have narrow profit margins, with little ability to accommodate increased operating costs. The remaining eleven producers, accounting for 23 percent of the coal produced, are much smaller "spot or local market" producers. Such operations with their relatively limited financial resources have great difficulty in complying with the reclamation bonding requirements taking effect July 20, 1981, and it is for this reason that the Governor's Advisory Council has recommended legislative action to authorize the development of alternative ways to meet the reclamation bond requirement.

Employment in the state's coal mining industry rose in recent years from 1300 in 1974 to a peak of 1617 in 1978. However, since early 1979, an estimated 450 coal industry workers lost their jobs due to adjustments by or within the major coal mining companies and attrition among the smaller operators.

In recent years Missouri coal production has been approximately 6 million tons. Consumption in 1979 was a little over 24 million tons, the electric utilities accounting for



22.5 million, industrial plants 1.5 million, and the balance by coke plants and retail sales.

## CONSTRAINTS AND MARKETS

Traditional mining and transportation costs are no longer the only determining economic factors in coal utilization; the cost of meeting sulfur-emissions requirements and of providing for land reclamation are also significant. In both respects Missouri coal is at a disadvantage: the average sulfur content of 4.2 percent is high compared to western coals; the yield of 3 to 4 thousand tons per acre is low, because Missouri coal occurs in relatively thin seams, resulting in comparatively high mining and land reclamation costs. Nevertheless, the general quality of Missouri coal is good, and it can compete in markets where sulfur-emission standards are not too stringent and where long-distance transport is not required.

Near-term markets for Missouri coal are largely limited to regional electric utilities and to use in local industrial boilers. Improved sulfur removal techniques, improved technology for sulfur-emission controls, and relaxed environmental regulations could enlarge this market. In the longer term, the emergence of new technologies for the use of coals to produce alternative fuels, i.e., synthetic fuels (synfuels), could provide an expanding market, and it is possible that with improved transportation systems and access to water transport, Missouri could benefit from a developing coal-export market. Specific emphasis needs to be placed on state governmental agency assistance in the development of markets for Missouri coal.

## CONCLUSIONS AND RECOMMENDATIONS

The Council concludes that Missouri's coal deposits are a basic energy source which could be developed well beyond their present state and make a larger contribution to the state's

economic health and energy security. Although Missouri coal is handicapped in national markets by relatively low yields per acre and high sulfur content, it should be expected to compete in local markets and to supply the state's needs.

Recommendations identifying the major policy issues deserving attention by state executive and legislative leaders are listed below. More detailed recommendations and suggestions are given in the text.

I. State Government should adopt a strong, positive commitment to the development and use of Missouri's coal resources.

II. State Government should adopt as a goal the use of Missouri coal by state electric utilities.

III. State Government should encourage the use of Missouri coal by industry.

IV. State Government should support legislation encouraging the use of Missouri coal in state institutions.

V. State Government should undertake a reassessment of state regulatory programs affecting the development and utilization of coal in Missouri and should make its concern apparent to federal regulatory agencies at Washington policy-making levels.

VI. State Government should take a position of strong, clearly defined support for coal gasification and other advanced coal-utilization projects.

VII. State Government should support identified research needs that directly affect development and utilization of Missouri coal. There is specific need for research on coal preparation and beneficiation and on more efficient mining of thin coal seams, for definitive market studies, and for investigating Missouri coal as a "feed" material for advanced coal-utilization technologies.

## INTRODUCTION

Missourians are increasingly concerned about the availability and cost of energy to meet present and future needs. The state's indigenous coal resources are widely recognized as sufficient to meet many of those needs, but their use is limited by environmental and economic constraints. Nevertheless, these resources are attractive because of their geographic location and the potential to contribute to the state's economic stability. What can state government do to encourage and support development and utilization of its coal resources?

Poor economic conditions, sharp increases in oil and gas prices with phased deregulation of those commodities, continued uncertainty about national energy policy, the expense of compliance with environmental regulations, and uncertainty about the effect of possible future regulations have contributed nationally to a complex, changing state of affairs in the coal industry.

In Missouri as elsewhere, coal mining, especially surface-mining, and the utilization of coal in conventional steam generating plants represent important areas of continuing and often conflicting concerns, which require understanding and, where appropriate, specific action by the state government. In the near future, extending certainly into the 21st century, coal will become increasingly

important as a key element of the world energy economy. Each of this nation's coal-producing regions will be affected and each existing coal-utilization sector will be influenced as dependence on coal expands. Notwithstanding the apparent inevitability of sharply increased levels of consumption of coal, there are many problems associated with coal development and utilization.

In its consideration thus far, the Coal Advisory Council has had opportunity to review only the salient features of the numerous issues that appear to define the current and future role of Missouri coal in the state economy. In this report the Advisory Council identifies current and near-term issues that are seen as being of particular importance at this critical period. Where appropriate, we suggest specific action. Finally, on the basis of our current thinking, we suggest a preliminary or tentative schedule of *Policy Options* that we believe will be helpful. These Policy Options are meant to serve as a basis for determining Missouri's future direction with respect to coal resource development and utilization, and particularly concern the need to insure optimum continuity in long-range planning and action at the Executive level. Each Policy Option will require periodic review and modification as conditions change, but should reinforce the important concept of state government commitment to long-range planning for coal-resource development and utilization in Missouri.

## COAL RESOURCE BASE AND COAL AVAILABILITY

Missouri's coal resource base is estimated at 47.4 billion tons. This includes all coal in seams 14 or more inches thick, regardless of their potential for economic recoverability.

### RESERVE BASE

The U.S. Geological Survey defines the *reserve base* as "a selected portion of the

resource base deemed to be suitable for mining by current methods." In this report the reserve base includes all coal in seams 28 inches or more thick, explored to some extent by drilling or mapping. Coal seams less than 28 inches thick are also included in the reserve base if such coal is currently being mined by surface methods. The total remaining recoverable coal reserve base of Missouri is approximately 5 billion tons.

## MEASURED RESERVES

Measured coal reserves are those based on closely spaced, very reliable control points. Thickness and continuity of the coal seams are confirmed by observation of outcrops, trenches, mine workings, and reliable drillholes. Measured reserves are considered to extend no more than one-half mile beyond the outcrops or other control points. Missouri's recoverable measured coal reserves exceed 875 million tons.

## POTENTIAL SUSTAINED ANNUAL COAL PRODUCTION

For near-term development, reserves in the measured category provide the most reliable data for computing the potential for sustained annual production. Reserves in this category are either under lease by mining companies or have been explored to some extent by drilling.

Based on recoverable measured reserves, Missouri's potential sustained annual production is 29 million tons per year, a figure obtained by dividing the amount of the state's recoverable measured reserve, 875 million tons, by 30 (years). This is not a prediction that the state's annual coal production will increase

to 29 million tons in the foreseeable future. Indeed, many economic and environmental factors remain to be overcome if Missouri's annual coal production is to increase by any substantial amount in the near future. However, it is apparent that Missouri possesses a sufficiently large coal reserve to allow substantial increase in production.

It is important to realize that the measured coal reserve, upon which the state's potential sustained annual production is based, is not a static figure, but ever changing. Mining depletes the measured reserve, and exploration increases it at the expense of the resource base. Missouri's 47.4 billion ton resource base should reassure those who fear that the state's coal resources might be depleted in a few decades, or even in a few hundred years. The combination of currently established or defined reserves plus necessary continuing exploration activity to prove additional reserves is Missouri's basis for projecting adequate supplies of coal for future requirements. A detailed, county-by-county tabulation of Missouri's coal reserves is included in this report as Appendix II. Additional information is available at Division of Geology and Land Survey offices at Rolla.

## PRODUCTION AND UTILIZATION OF MISSOURI COAL

### STRUCTURE OF COAL MINING INDUSTRY IN MISSOURI

An understanding of the nature of the coal mining industry in Missouri is essential to development of initiatives to assist the industry and promote sound and orderly growth.

There are basically two types of coal mining operations in Missouri:

1. Life-of-contract mine operations
2. Spot-and-local-market producers

"Life-of-contract" mine operations account for the largest volume of production. In 1979

three such companies accounted for 77 percent of the coal mined in Missouri; the remaining eleven companies, in the "spot-and-local-market" category, accounted for the remaining 23 percent of Missouri coal production. The problems affecting growth in each category are markedly different, as is the financial ability of the companies to cope with these problems.

By the nature of the long-term contracts, "life-of-contract" mine operators deal with very narrow profit margins. Increased operating

costs that cannot be passed through under the terms of the contract must be absorbed.

Although coal prices and profit margins reflect the short-term nature of "spot-and-local-market" operations, the major problem facing the smaller producers are land reclamation requirements, including reclamation bonding. The price structure is flexible and competitive, but the bonding problems for these smaller operators have proved formidable; therefore, the Governor's Advisory Council has recommended legislation to amend the Missouri coal surface-mining law to authorize development of alternative ways for small operators to meet bonding requirements. HB 116, introduced in the current session of the Missouri General Assembly, will provide flexibility in bonding and benefit both large and small operators.

## **EMPLOYMENT IN COAL MINING**

According to the Missouri Department of Labor and Industrial Relations, employment in the coal mining industry in Missouri peaked at 1617 in 1978. Since then the number of miners employed has declined: 1331 in 1979 and 1135 in 1980. In this relatively short time, 482 jobs have been lost in the coal mining industry in Missouri, mainly because of (1) adjustments within major coal mining companies and (2) attrition among smaller operators unable to cope with the administrative burdens of federal and state strip-mine laws.

Two major mine operations have changed extensively during the past 24 months. The Peabody Coal Company's Tebo Mine closed in late November 1979, permanently eliminating 88 jobs, and operations at the Company's Power Mine were reduced temporarily. Peabody's Bee-Veer and Prairie Hill Mines were sold to Associated Electric, and operations at the Bee-Veer Mine were subsequently halted. There was essentially no change in total mine worker employment.

During the winter of 1979-80 and in subsequent months, a number of small-to-

medium-scale operators have either gone out of business or sharply reduced operations because of strong competition for the local market, a loss of markets in neighboring states due to executive orders requiring the use of domestically produced coal in tax-supported institutions in those states, inadequate capital, poor management, or the burden of mined-land reclamation regulations. However, one new medium-scale mine began operations in October 1980.

The closing of a large mining operation such as the Tebo Mine has far reaching effects on the economy of the surrounding region, in addition to, and beyond, the considerable personal loss of the displaced miners. Businesses, banks, real estate concerns, and others who provide goods and services to mine operators and who depend on the mine payroll to provide a stable consumer base are also affected. Information provided by Division of Community and Economic Development indicates that for each two (2) coal-mine industry workers, one (1) other worker is required in a support job.

Although coal mining is not a major employer in Missouri, currently employed workers are an important element in the local economy of many communities. Division of Community and Economic Development projections indicate that the economic value of the coal mining industry to the state's economy in 1980 was over \$84 million. A large part of this total was spent locally and was of major significance at that level.

## **THE MARKET FOR MISSOURI COAL**

The market for coal is controlled by demand, with most of the product destined for short-term storage or immediate use. Operators produce supplies to meet demands, so that the amount of coal marketed corresponds closely to reported production. In addition to basic economic and transportation considerations, the critical constraints to increasing the market for Missouri coal are 1) characteristically high sulfur content and 2) relatively high land-reclamation costs per ton produced from surface mines.



**NATIONAL TRENDS:** The United States produced approximately 825 million tons of coal in 1980, a significant increase above 1979 production. This upward trend is expected to continue as coal increasingly becomes a major energy source. National coal production, expected to top 1 billion tons per year by 1990, will approach twice that by 2000.

In 1979, 549.8 million tons of U.S. coal went to electric utilities, 77 million tons to coke plants, 67.4 million tons to industrial plants, 1.9 million tons was distributed for retail sales, and 65.2 million tons was exported. Growth in coal use is expected in electric utilities and other industry, and in exports. A new coal-consuming industry, synthetic fuels, is expected to mature later in this century.

**MISSOURI TRENDS:** During the 1970's, coal production in Missouri increased 45 percent, from 4.5 million tons in 1970 to 6.5 million tons in 1979. Highest production was 6.6 million tons in 1977; lowest, 4.0 million tons in 1971. Preliminary figures indicate that just over 5.5 million tons of coal was produced in 1980, a loss of nearly 1 million tons from 1979. Closing Peabody Coal Company's Tebo Mine accounted for approximately 600,000 tons of this loss.

Fuel for generation of electricity by utilities continues to be the primary market for Missouri coal. During 1979, 24,356,000 tons of coal was consumed in Missouri, electric utilities accounting for 22,451,000 tons. Coke plants consumed 270,000 tons, industrial plants 1,551,000 tons, and retail sales accounted for 84,000 tons.

Because coal production in Missouri is controlled by demand, future production trends will rise or fall with it. The future of Missouri coal is clouded with respect to its principal market, the electric utilities industry. Still to be determined is the full impact on the use of high-sulfur coal, of the U.S. Environmental Protection Agency's recently announced requirement for sulfur removal units on all new power plants.

For the foreseeable future, it appears that the use of Missouri coal by electric utilities will continue at about the same level, or perhaps increase modestly. The use of Missouri coal by industrial plants appears to be increasing moderately; currently the greatest growth is in the cement industry.

#### **DEVELOPING TRENDS IN COAL EXPORT:**

Recent sharp increases in oil prices, and political unrest in the Middle East have stimulated the interest of foreign buyers in U.S. coal. During the first half of 1980, 31 million tons of coal, 50 percent more than in the same period in 1979, were shipped to foreign markets. Of particular interest is the growth in export tonnage in the steam-coal market. Overseas shipments of steam coal during the first half of 1980 reached 5.1 million tons nearly an eight-fold increase over the same period in 1979.

The lack of adequate U.S. port facilities export has become a controversial issue. Existing coal-loading facilities at U.S. ports cannot handle the present demand, and without major improvements, will certainly not be able to keep pace with the potential future export market. The *Wall Street Journal* reports that U.S. investors are unwilling to invest the billions of dollars necessary to increase exporting capacity significantly, until foreign coal users sign long-term contracts with U.S. coal producers. Foreign utilities, on the other hand, refuse to sign long-term contracts until commitments are made to expand U.S. port capacity. Current reports in the news media and in trade periodicals indicate that such commitments are now being made.

Despite these problems, global economic and political factors will probably assure an increase in U.S. coal exports. The International Energy Agency concludes that the U.S. must export 100 million tons of coal annually by 1990 and 300 million tons annually by the year 2000, to meet free-world energy needs. More detailed information about international coal export markets will be available through reports of the

Interagency Coal Export Task Force, established by President Carter in Spring 1980, which is supported administratively by the Department of Energy and has prepared an Interim Report. Other efforts are under way to determine the potential export market for *high-sulfur* coal from the Eastern Interior Basin, specifically Illinois. The principal export market is for low-sulfur "compliance" coal.

**EFFECT OF INCREASED U.S. EXPORTS ON MISSOURI COAL PRODUCTION:** An increased U.S. coal export market will probably indirectly affect the market for Missouri coal. Most of the proposed expanded port facilities are on the East Coast and will export coal moving from Appalachia. A proposed port expansion project at the Port of New Orleans will probably export coal moving down the Ohio and Mississippi Rivers from Kentucky, Illinois, Indiana, and Ohio. High-quality low-sulfur coal from Oklahoma will probably move down the Arkansas River to New Orleans for export.

Although a number of states are in a better position than Missouri to supply the overseas coal export market, the stimulation of the general coal market, should a substantial export market develop, would in turn benefit the Missouri market.

Although the potential for exporting coal is not as attractive for Missouri as for a number of other states, it should not be discounted. Much of the coal in north-central Missouri is near transportation on the Missouri and Mississippi Rivers; hence, there may be a future export market for some Missouri coal. It is apparent, however, that the principal effect of development of strong export markets for U.S. coal will be of a *secondary* nature.

**OTHER MARKET FACTORS:** New generating plants constructed under the provisions of the Municipal Power Pooling Admendment (November 1978) represent an important potential market for Missouri coal. Power-supply needs that might be met through joint ventures among municipalities, cooperatives, and investor-owned utilities are being studied

by the Missouri Joint Municipal Electric Utility Commission (Richard Malon, Columbia—Chairman), which is currently working with Associated Electric Cooperative, Inc., Springfield, in joint planning.

**MARKETS — SUMMARY:** In summary, the near-term market for Missouri coal is largely limited to the electric utilities. Expansion of that market would require substituting Missouri coal for Illinois and Oklahoma coal in existing plants, and increased emphasis on construction of new plants capable of using it. Additional Missouri coal would be utilized in accordance with provisions of proposed legislation (HB 637; SB 342), requiring specific consideration of Missouri coal as a fuel in state buildings. Such a requirement is seen as effective in demonstrating new coal-burning technology, e.g., fluidized-bed combustors. Construction of new facilities for the use of coal mined in the state may be planned in order to meet combined regional need of municipalities by "pooling." It is necessary to increase efforts to market expanded production of Missouri mines. Some increase in the market for spot sales to industrial users is expected as that market expands. Coal gasification plants, such as those proposed by Consumer Energy Corporation for locations in central and northern Missouri, would mean an assured market for substantial tonnages of coal.

## **NEW DEVELOPMENTS IN COAL MINING AND UTILIZATION IN MISSOURI**

During the past few years a number of new energy facilities which could use Missouri coal have been proposed. These facilities, which are in various stages of planning and development, are discussed below.

Associated Electric's 670 megawatt Thomas Hill generating unit will go on-line in 1982 and will increase coal consumption at the Thomas Hill plant by more than two million tons. This coal will come from the nearby Prairie Hill Mine, which will eventually produce 3.8 million tons annually.

Springfield City Utilities' Southwest 200 megawatt No. 2 Unit, which will consume approximately 500,000 tons of coal annually, will go on-line in 1985. The coal will probably come from the Western Interior Basin; at least some of it will probably be Missouri coal.

Within the past 5 to 10 years, extensive, well-publicized plans have been proposed for three major facilities to convert Missouri coal to low or intermediate gas, or other products: Consumer Energy Corporation's proposed plants at Reger, in Sullivan County and at Yates, in Howard County, and the proposed Missouri Energy Center near Palmyra, in Marion County.

The Consumer Energy Corporation plants would employ combined-cycle power generation technology to generate electricity and to produce methanol (methyl alcohol) and other products. Consumer Energy Corporation and Associated Electric Cooperative, Inc., formed a joint venture to carry out a proposed

feasibility study of the two proposed projects. Proposals for financing a feasibility study were submitted to the U.S. Department of Energy but were rejected. CEC is attempting to secure private financing to continue project development.

The Missouri Energy Center, proposed during the mid-1970's, was to convert high-sulfur Missouri coal to electric power, and ammonia for the production of ammonia-based fertilizers. At last report, the project was "on-hold," awaiting more favorable economic conditions.

In the fall of 1980, Wyoming Fuels of Denver, Colorado opened their "Tri-County" Mine north of Mexico, in Audrain County. Production goals are not available but will probably be more than 100,000 tons of coal per year. Mexico Coal Company is reported to be planning to reactivate their mining operation, with a project production level of around 100,000 tons per year.

## CONSTRAINTS TO THE UTILIZATION OF MISSOURI COAL

Traditional mining and marketing factors are no longer the sole determining economic factors involved in the cost of utilizing coal. The costs of land reclamation and sulfur-emissions control frequently overshadow the costs of mining, transporting, and burning coal of specific coal fields. In the case of electric-utility fuel, the problem often amounts to comparing the cost of long-distance transport of western low-sulfur coal, to the cost of removing the sulfur from Missouri coal. It is uncertain what the full effect of the U.S. Environmental Protection Agency's recently announced ruling, requiring installation of scrubbers on all power plant stacks, will be on the use of Missouri versus western coal by utilities. Also uncertain is the outcome of legislation (HB 492) introduced in the current session of the Missouri Legislature, that would allow fuel-adjustment clauses for electric utilities in Missouri, including the cost of fuel transportation.

Missouri coal has always been considered a fair to good steam coal, although it is higher in ash and sulfur and somewhat lower in Btu content than coal from Appalachia. It is quite similar to most Illinois coals and considerably higher in Btu content and lower in moisture than most western coals, including those from the northern Great Plains and the Powder River Basin of Montana and Wyoming. The average Btu content of Missouri coal (from mine-face sampling) is 11,100 Btu/lb; average ash content, 11.5 percent, and average sulfur content, 4.2 percent.

The quality of Missouri coal can be upgraded by improved coal-preparation procedures. More attention to reduction of sulfur and ash would result in a more desirable, more uniform product better suited to utility and industrial uses. Sulfur content cannot be reduced by existing coal-preparation techniques to the level required by EPA's New Source Perform-

ance Standards (NSPS) for utilities. However, reduced levels of sulfur and ash would make SO<sub>2</sub> scrubbing less expensive and less troublesome mechanically. The combined effect of high-sulfur content and high mined-land reclamation costs per ton of coal produced place Missouri coal at a disadvantage, particularly in comparison to western low-sulfur coal. The effect of the high-sulfur content is discussed in the following material on air quality.

### THE EFFECT OF AIR QUALITY REGULATIONS

Coal production and utilization directly affect Missouri's air quality. Air-quality regulations, which affect the use of coal, are a primary concern of the state, because the generation of electricity within it is so dependent on coal. Over 90 percent of the more than 24 million tons of coal used annually in Missouri is used to generate electrical power.

Burning coal produces two major pollutants: sulfur dioxide (SO<sub>2</sub>) and particulate matter. Since Missouri coal has a relatively high sulfur content of 4-5 percent, regulations concerning SO<sub>2</sub> emissions are the major concern and will be addressed here.

In Missouri two major classes of industry burn coal: one includes coal-fired power plants and industrial process plants, such as cement plants; the other, industrial-size boilers. Each class has its own specific constraints with respect to air quality and coal utilization. These constraints are also affected by whether or not the specific facility is considered an *existing* or a *new* source.

The largest coal consumers are the existing coal-fired power plants, which must meet both state and federal regulations limiting SO<sub>2</sub> emissions. Before 1977, regulations specifically limiting SO<sub>2</sub> emissions for power plants existed only in the St. Louis area. In 1977 the state, under EPA stimulus, implemented regulations that limited existing major SO<sub>2</sub>

sources to approximately contemporary emission levels, and limited any existing sources which had not been assigned a specific limit to eight (8) pounds of SO<sub>2</sub> per million Btu, a sulfur and Btu content consistent with most Missouri coal. Table 1 lists Missouri power plants with the emission limits mentioned above and lists any SO<sub>2</sub>-control equipment they may have.

A federal regulation was enacted in 1973, under New Source Performance Standards (NSPS) for fossil fuel-fired steam generators, limiting power plants on which construction was begun after 1973 to no more than 1.2 pounds SO<sub>2</sub> per million Btu heat input, which corresponds to an equivalent sulfur content of 0.6 to 0.8 percent sulfur. Table 1 shows the plants affected by this NSPS regulation.

In 1970 state regulations were enacted limiting SO<sub>2</sub> emissions in the St. Louis area to 2.3 pounds per million Btu, causing problems for two Union Electric facilities. Both plants, Portage Des Sioux and Labadie, were unable to meet the emission regulations. After careful study and consultation with EPA and the state, their emission limits were raised to 4.8 pounds per million Btu.

In 1979, NSPS regulations for coal-fired power plants were amended to further restrict emissions. Basically, the amended regulations require a maximum emission limit of 1.2 pounds per million Btu and a flue-gas desulfurization efficiency of 90 percent for high-sulfur coal and 70 percent for low-sulfur coal. EPA designed the regulation to discourage interstate transportation of coal and to promote use of locally available coal.

### EFFECT OF SO<sub>2</sub>-EMISSION REGULATIONS ON USE OF MISSOURI COAL

Coal use in power plants in existence before 1973 has not been affected by state or federal regulations. For such plants, SO<sub>2</sub> limits were set at emission levels before regulation; hence,



their coal sources were based primarily on economic factors, plant-design factors, and location.

As shown in Table 1, four operating utilities in the state are currently under NSPS regulation. Construction on all four plants was begun before the 1979 NSPS amendments; in each case, therefore, installation of scrubbers was voluntary, in an effort to comply with the NSPS limit of 1.2 pounds  $\text{SO}_2$  per million Btu. Only one plant will burn Missouri coal: Associated Electric's Thomas Hill Plant, Unit #3, a mine-mouth operation. Associated Electric found it more economical to eliminate transportation costs, and scrub to meet the 1.2-pound limit. Of the other plants, Kansas City Power and Light's Iatan Plant is burning low-sulfur western coal, and Springfield City Utility's Southwest Plant and Sikeston Municipal Utilities are using scrubbers and burning Kansas and Illinois coal, respectively. Sikeston and Thomas Hill #3 are still under construction. In each case, the choice of coals and the decision to install scrubbers was based primarily on economic factors, such as comparative costs of available coals.

There had been some concern about air-quality regulations limiting use of Missouri coal in *new plants*, but the 1979 NSPS regulation was intended to remove this concern, since new power plants must install flue-gas desulfurization, regardless of the sulfur content of the coal they burn. However, some concern has been expressed about the ability of any scrubber to maintain 90-percent efficiency continuously. Some utilities, rather than face possible noncompliance penalties, may choose to burn low-sulfur coal and scrub to 70-percent efficiency. Increased costs of scrubber-sludge disposal are another potential problem with this amendment, further study of the effects of which on the utility industry is recommended. The matter is undoubtedly being studied by industry.

Industrial boilers are the other major type of coal-burning facility in the state. Missouri regulations for *existing* facilities require a limit of 8 pounds  $\text{SO}_2$  per million Btu; therefore,

$\text{SO}_2$  regulations are not a major barrier to the use of Missouri coal in industrial boilers. Existing boilers are usually gas fired, because natural gas was once cheaper than coal and its use required no particulate-control devices. The possibility of returning to coal as a fuel in existing gas-fired facilities depends on their conversion capacity. Boilers must be modified to burn coal instead of gas, pollution-control equipment must be purchased to control particulate emissions, and physical requirements, such as room for the pollution-control equipment and coal storage, must be met. Coal-handling and other equipment must also be purchased. The use of *any* coal would be affected by such limiting factors. Because of the small quantity of coal used in such facilities and the lower cost of Missouri coal, there is a strong economic incentive for industry to use Missouri coal if coal proves to be a feasible alternative fuel.

Most other states have far more stringent  $\text{SO}_2$ -emission regulations than Missouri. For example,  $\text{SO}_2$ -emission limits for the State of Illinois are 1.2 pounds per million Btu for facilities greater than 250 million Btu of heat input per hour, and 1.8 pounds per million Btu for facilities less than or equal to 250 million Btu of heat input per hour. Kansas  $\text{SO}_2$  regulations restrict emissions to 1.5 pounds per million Btu. In every state, *all new facilities* greater than 250 million Btu per hour must meet the 1979 NSPS regulations.

Air-quality regulations are one of the factors that must be considered in developing synthetic fuel plants. This is an important matter, as two coal gasification plants are in advanced planning stages in Missouri, and two or more other proposals have been seriously considered in the last few years. At present, Missouri has no air-quality regulatory plan directed specifically toward coal gasification or liquefaction facilities. Indeed, there is little available information concerning the effects on air quality of coal-gasification or coal-liquefaction operations. Current studies are identifying air-quality problems associated with commercial-scale plants in Germany, and EPA

Table 1  
UTILITY PLANTS AND SO<sub>2</sub>-EMISSION LIMITS IN MISSOURI

Facility	Emission Limit (lb/million Btu)	Control Equipment
Kansas City Power & Light		
Hawthorne	6.1	
Montrose	12.9	
Grand Avenue	9.0	
Iatan NSPS*	1.2	
Missouri Public Service		
Sibley	9.0	
Pleasant Hill	8.0	
St. Joseph Power & Light		
Lake Road	8.6	
Edmond	8.0	
Associated Electric Coop.		
Thomas Hill #1 and #2	9.5 (8.0 after 1/1/82)	
Thomas Hill #3 NSPS*	1.2	scrubber
New Madrid	10.0	
Union Electric		
Labadie	4.8	
Rush Island	2.3	
Portage Des Sioux	4.8	
Meramec	2.3	
Columbia Water & Light	8.0	
UMC Power Plant	8.0	
UMR Power Plant	8.0	
City of Springfield		
James River	9.2	
Southwest NSPS*	1.2	scrubber
Central Electric Coop. - Chamois	6.7	
Chillicothe Utilities	8.0	
Marshall Utilities	8.0	
SEMO Power Plant	8.0	
Ark-Mo (Campbell)	8.0	
NE Mo Electric Coop. - Palmyra	8.0	
Empire District - Joplin (Asbury)	8.0	
Independence Power & Light	6.3	
Sikeston NSPS*	1.2	scrubber

is developing air-pollution control guidelines for the industry. Missouri air-quality officials are striving to remain abreast of developments in this area, and to identify and develop permit procedures appropriate to such facilities, so that regulatory requirements will be as clearly defined as possible, as commitments for development are made.

In Missouri, an important air-quality issue related to the burning of coal is the potential problem of *acid rain*, which is believed to be caused by emission of sulfur oxides and nitrous oxides into the atmosphere, by power plants and other sources. In the atmosphere these oxides are believed to combine with water vapor to form sulfuric and nitric acids, which eventually form acid rain, already becoming a serious problem in the northeastern states, where a number of lakes have become acidified, causing fish kills. At present, however, there is no known evidence of acid precipitation within the state. Mr. Gary S. Henderson, Associate Professor of Forestry at the University of Missouri—Columbia, will establish acid-rain monitoring stations in the Ashland Wildlife Area and at University Forest, near Poplar Bluff.

Missouri power plants may be contributing to the acid-rain problem in the eastern part of the country. However, until more information is available, and more substantiating data are collected, additional SO<sub>2</sub>-emission controls should not be necessary. Missouri's Air Quality Program will continue to monitor current acid-rain studies in order to provide both state government and industry with additional information as it becomes available.

The continuing national review of the Clean Air Act may result in some changes that would favor expanded use of Missouri coal; however, it is much too early to anticipate results of this important review process.

## **COAL MINING AND LAND RECLAMATION**

Passage of, and compliance with, the very comprehensive Surface Mining Control and

Reclamation Act of 1977 has tended to emphasize (and exaggerate) the marginal nature of mining Missouri coal. Coal-quality and mining and reclamation costs add more to coal-production costs from the state's thinner coal seams than they do in states with substantially thicker coal seams. Yields per acre vary rather widely in Missouri but normally range from about 3000 to 4000 tons per acre. In other states, thicker coal mined from similar depths often yields 6000 to 10,000 tons per acre, and in the western states some coal fields yield more than 100,000 tons per acre.

The costs of coal mining and subsequent land reclamation are highly variable and depend on many factors, a few of which are seam thickness, soil type and thickness, overburden thickness and type, topography, operator efficiency, and permitting cost. In Missouri, although very little specific information has been made available, it appears that mining and reclamation costs range from about \$16 to \$28 per ton, whereas costs in Illinois range from about \$11 to \$18 per ton. Mining and reclamation costs for western coal are estimated to range from about \$6 to \$12 per ton.

The amount of land affected by surface coal mining is of continuing interest to Missouri citizens. Current information reveals that at an annual production level of 6 million tons, coal is removed from about 1500 acres. However, nearly as much land is required for support activities relating to mined-land reclamation, coal transport and preparation, and other needs, so that the total area affected during any year may be as much as 3000 acres, all of which receives an appropriate level of reclamation work.

During 1980, 12 companies operating in several places were largely responsible for Missouri coal production. It is anticipated that 14 companies will be active during 1981 and that coal production may increase slightly, largely because of expansion of the Thomas Hill Energy facility of Associated Electric Cooperative, Inc. Table 2 is a list of the companies having land permits from the Land

Table 2  
ACREAGES UNDER LAND RECLAMATION COMMISSION PERMIT,  
JANUARY 1981

Company	County	Total Acres Permitted
Associated Electric, Bee-Veer Mine *	Macon	3,445
Associated Electric, Prairie Hill Mine *	Randolph	3,920
Associated Electric, Prep. Plant	Randolph	53
Bill's Coal Company, Inc.	Vernon	793
Coal Creek Fuel Company	Randolph	56
Holiday Coal Company, No. 1 Mine	Howard	130
Holiday Coal Company, Charity Ann Mine	Howard	89
Howard County Coal Company	Howard	85
Mexico Coal Company	Audrain	149
Midwestern Mining and Reclamation	Vernon	641
Missouri Leasing and Investment Co., Inc.	Cooper	13
Missouri Mining, Inc.	Putnam	3,183
NEMO Coal, Inc.	Randolph	1,183
Peabody Coal Company, Power Mine North	Henry	1,994
Peabody Coal Company, Power Mine South	Henry	1,993
Peabody Coal Company, Tebo Mine **	Henry	4,235
Pittsburg and Midway, Empire Mine	Barton	3,544
Pittsburg and Midway, Midway Mine	Bates	3,609
Universal Coal and Energy Company, Inc.	Randolph	1,159
Wyoming Fuel Company, Tri-County Mine	Audrain	103
Wyoming Fuel Company, Prep. Plant	Audrain	67
TOTAL		30,454

\* Mines purchased from Peabody Coal Company, coal production terminated at Bee-Veer with reclamation work continuing.

\*\* Inactive

Reclamation Commission. The acreage figures include former mining areas, the total reclamation bond for which has not been released by the Commission; active mining areas; and in the case of some companies, future mining areas of the next 2 to 10 years.

**MINED-LAND RECLAMATION LAW AND REGULATIONS:** The development of a national mined-land reclamation law, Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977, and regulations in accordance with that law have been widely perceived as major steps toward the protection and conservation of land and water resources, with special emphasis on returning mined land to productive uses.

The Federal Act declares that the primary governmental responsibility for developing and enforcing regulations for surface-mining and reclamation operations subject to the Act should rest with the states. Title V provides for a phased implementation of the Act, with an interim regulatory period beginning in Missouri on May 3, 1978, and either a state or federal permanent regulatory program in operation by January 3, 1981.

The Missouri General Assembly responded during the 1978 legislative session by amending sections 444.500 to 444.755, RSMo, by adding section 444.535 so that the Land Reclamation Commission could administer the interim program required under the Federal Act. Interim program regulations for Missouri, under provisions of the Department of the Interior's Office of Surface Mining, have been promulgated and in effect since September 2, 1978.

During the 1979 Session, the General Assembly passed House Bill 459, the surface coal mining law, sections 444.800 through 444.940, RSMo, which gave the Missouri Land Reclamation Commission a legal basis to administer the permanent regulatory program. In compliance with the Federal Act (PL 95-87) and regulations, information (in a document of

more than 2000 pages) was submitted to the Office of Surface Mining in order for that office to determine the state's legal and administrative ability to carry out the provisions of PL 95-87. This implementation plan was adopted by the Land Reclamation Commission and submitted to the Office of Surface Mining on February 1, 1980. On September 25, 1980, Cecil Andrus, Secretary of the Department of the Interior, offered conditional state program approval to Governor Teasdale. These conditions were accepted by the Land Reclamation Commission and the Governor on October 28, 1980. Official conditional approval of Missouri's program was effective on November 21, 1980, thus giving the Land Reclamation Commission primary responsibility for regulating surface coal mining in Missouri. Since the passage of the Federal Act in 1977, rapid but deliberate development of the Land Reclamation Program staff in the Department of Natural Resources has taken place with the support of an increasingly dedicated State Land Reclamation Commission.

The surface coal mining law provides for a state permit system for all surface coal mining and reclamation and coal exploration activities. Although there presently are no underground coal mines, the law provides for environmental protection for the surface effects of underground mines should such operations be developed in the future.

In order to ensure adequate environmental protection and final reclamation, the Land Reclamation Commission administers a performance bonding system obligating the coal companies to perform work according to approved mining and reclamation plans, or will provide adequate funds to the Land Reclamation Commission if companies default on their responsibilities. Major requirements in the surface coal mining law include topsoil removal and replacement, return of mined land to approximate original contours, return of land to equal or better productive capacity, special handling of prime farmland soils, and protection of the hydrologic balance.



Before receiving a permanent program permit each company must submit information concerning the assessment of all environmental and cultural resources in the mining area and information concerning plans to protect or mitigate adverse effects on them. Each company must receive approval of plans for general operations and reclamation; blasting; protection of the hydrologic balance, including surface and groundwater; roads and transportation facilities; soil handling; backfilling and grading; revegetation and postmining land use; and a bond release plan.

Under provisions of the Federal Act all Missouri coal operators would be required to operate under a permanent program permit after July 20, 1981, eight months from the date of approval of the state program as required by the Federal Act. Currently, it appears that implementation of bonding provisions of the permanent program in Missouri may be deferred, pending resolution of the many problems that have beset that aspect of OSM regulations. Modification of Office of Surface Mining regulations has received very high priority under the Reagan Administration, with emphasis on referral of responsibility to the states. The period of transition to this approach is certain to be a difficult one for the states as well as OSM, and has resulted in efforts to defer all aspects of Missouri's permanent program implementation.

**PRIME FARMLAND:** One purpose of Public Law 95-87 is to assure that the coal supply essential to the nation is provided and that there is an appropriate balance between environmental and agricultural needs, and the need for coal. Missouri is fortunate to have a large acreage of prime farmland from which to reap the benefits of high agricultural productivity. Currently, the generally accepted method of mining such land is to remove separately the A and B horizons

(major divisions of natural soil-profile development) with pan scrapers to a depth of 40 to 48 inches (the rooting zone) and then replace them in proper sequence. Mining in this manner is very expensive in proportion to the amount of coal recovered.

Lands currently mined in Missouri are approximately 50 percent prime farmland and 50 percent nonprime land. Although operational costs vary widely, the removal, storage, and replacement of 40 to 48 inches of topsoil on prime farmlands will cost between \$12,000 and \$16,000 per acre. However, these costs can be reduced as much as 50 percent by efficient operation and by avoiding multiple handling of soil materials. Based on these figures and a production of 4000 tons per acre, it is conceivable that the cost could reach \$4 per ton on prime farmlands. Costs for topsoil removal, storage, and replacement on nonprime lands are approximately \$3,500 to \$4,000 per acre, or \$1 per ton.

It is in the interests of the citizens of the state that prime farmlands be adequately protected by requiring return of these disturbed soils to equal or better production capacity. However, since it is also important to keep energy costs as low as possible, more research is needed to discover more economical methods of mining coal from prime farmland without sacrificing productivity.

The Land Reclamation Commission recognizes this problem and has encouraged the coal industry to develop alternative methods of mining prime farmland. In October 1980, the Commission approved plans for an alternate mining method for one operator, which it believes will not sacrifice postmining productivity. It is currently considering other proposals.

## DEVELOPING NATIONAL POLICY ON COAL

National policies on coal are determined by several laws and a myriad of regulations and administrative policies.

Major federal laws that affect coal include the following:

- Powerplant and Industrial Fuel Use Act of 1978
- Energy Tax Act of 1978
- Surface Mining Control and Reclamation Act of 1977
- Clean Air Act and Amendments
- Energy Security Act of 1980
- Windfall Profits Tax Act
- Resource Conservation and Recovery Act of 1976
- Natural Gas Policy Act
- Federal Water Pollution Control Act of 1972 and Amendments

The Powerplant and Industrial Fuel Use Act (FUA) requires all powerplants constructed after the passage of the act, and many large industrial boilers constructed after 1978 to use coal as their primary fuel. However, there are some very complex exceptions. Currently, action to void provisions of this act, which require all large powerplants to convert to coal by 1990 are being proposed in Congress by states that have been generating power with natural gas.

The Energy Tax Act was designed to provide some tax incentives for many types of energy investments, including the construction of coal boilers in industrial applications. Its provisions will expire on December 31, 1982.

The Surface Mining Control and Reclamation Act and the Clean Air Act and Amendments were discussed in previous sections and will not be discussed here. Both have had major effect in shaping the nation's energy policies, including those relating to coal.

The Energy Security Act of 1980 authorizes establishment of the United States Synthetic

Fuels Corporation, which will provide financial assistance in the development of energy from tar sands, coal, oil shale, and hydrogen from water. In addition, it authorizes a ten-year program to determine the causes and effects of acid rain and prepare a plan to correct the acid-rain problem. A \$3-million study of the threat of carbon dioxide from fossil fuels has also been approved.

The Windfall Profits Tax Act generates the money for the Synthetic Fuels Corporation, from the tax on petroleum.

The Natural Gas Policy Act provides for deregulation of natural gas in stages, with final deregulation in 1984. The price of natural gas is expected to rise to that of number-two (#2) oil, deregulated on January 28, 1981 by Executive Order of President Reagan.

There are other federal laws that affect production and use of coal; we have tried to list only the major ones. Obviously any current or future federal actions concerning solid-waste disposal could affect the viability of coal. At present, there are no serious constraints in this area, other than in the production of synthetic fuels. Some products and byproducts of synthetic-fuel production can be considered "hazardous," and they may be subject to the hazardous-waste laws. Because this is a new area, there is little available information about the possible extent of this potential problem.

The legislation briefly covered in this section required many years for Congressional approval. There is still much debate concerning changes that are needed in existing legislation. The coal policies of the federal government might be summarized as follows:

- Emphasis on increased dependence on coal as an energy resource, with a concomitant dedication to maintaining the integrity of air, water, and soil resources. The problem has been to find points of agreement on methods and procedure of

implementing these objectives. *It is anticipated that emphasis on coal must continue and increase.*

- Accelerated coal-based synthetic fuels production as a means for self-sufficiency in liquid and gaseous hydrocarbon fuels. *Currently it appears that synthetic-fuel development is being deferred to private industry, with minimal government involvement.*
- Continued emphasis on the use of western low-sulfur coal. Federal planners believe western coal to be more viable economically than eastern high-sulfur coal, but *many believe that water resources and transportation costs will be limiting factors.*
- A commitment to regulate the mining of coal to ensure minimal environmental damage. However, there is much

disagreement concerning what constitutes "damage to the environment" and what constitutes "permanent damage." *Land-reclamation policies have been much criticized and are now being modified.*

These factors are part of an evolving national coal policy that began in the early- to mid-seventies and which is fragmented. Their effects on Missouri coal will be varied. Lacking a stated position, it is difficult for Missouri's viewpoint to be expressed and considered in the formation of national coal policy. The midwestern coal-mining states are capable of producing much of the nation's coal and should not be ignored by national policy makers. Missouri should have clearly defined policies on coal mining and utilization that reflect the character of its resource base, and its current and projected developmental needs.

## DEVELOPING TECHNOLOGIES APPROPRIATE FOR UTILIZATION OF MISSOURI COAL

Environmentally, Missouri coal poses a very difficult problem for the various coal-utilization technologies. For most combustion processes, the 4- to 5-percent average sulfur content must be reduced to meet current environmental standards. Therefore, growth in the use of Missouri coal will greatly depend on development and utilization of equipment to reduce or eliminate sulfur emissions economically. A number of utilization techniques exist today. Some are able to cope with the problem of sulfur; others are not. Coal-beneficiation techniques offer alternatives for increasing the utilization of Missouri coal.

### DIRECT COAL COMBUSTION

Direct coal combustion is the simple burning of crushed or pulverized coal in furnaces to produce heat and steam for industry and generation of electric power. Missouri coal is already extensively used in this way. The gases produced pass through flues and are dissipated in the atmosphere. Without pollution-control

equipment, however, emissions of sulfur dioxide, nitrous oxide, particulates, and other pollutants may exceed regulatory limits. Therefore, in order to meet environmental standards, this technique requires cleanup (scrubber) equipment in the flue-gas stream. When high-sulfur coal is burned directly in large plants, scrubbers are usually required.

### FLUIDIZED-BED COMBUSTION

Fluidized-bed combustion is a direct-combustion technique capable of removing much of the sulfur from coal in the furnace, and it does not require scrubbers to remove sulfur dioxide. However, the technique requires cleanup equipment, such as cyclones or baghouses, to control particulates. Combustion takes place in a "bed" of inert material that is "fluidized" by passing air through it from below. Coal and limestone are fed into the bed, and heat of combustion calcines the limestone to calcium oxide (lime), which combines with sulfur to form calcium sulfate (gypsum).



Fluidized-bed combustion at atmospheric pressure has been developed to such a degree that manufacturers can give performance guarantees for industrial-scale boilers.

## **COAL/OIL MIXTURES**

Coal/oil mixtures can decrease the dependency of some combustors on oil. Microfine coal mixed with oil is burned in a conventional oil burner. Problems associated with this technique are the relatively high sulfur content of the mixtures, increased particulate emissions, and possible separation of the coal and oil during storage. Advantages are that it may decrease oil consumption in some plants and it could increase the economic viability of oil-dependent plants. This technique is being developed by major corporate interests and demonstrations are underway.

## **COAL PELLETIZATION**

Coal pelletization is the grinding, blending, and pelletization of limestone, coal, and other materials to form pellets about one-half inch in diameter. The result is that with combustion, 50 to 85 percent of the sulfur from the coal is removed and disposed of with the ash. This fuel is relatively expensive, because there are no commercial plants producing it. However, it would be particularly suitable for existing plants that must reduce sulfur emissions or that would prefer to use locally available high-sulfur coals.

## **MAGNETOHYDRODYNAMICS (MHD)**

Magnetohydrodynamic power generation is a possible future direct coal-combustion technique that could result in thermal efficiencies of 50 percent or more and a 90-percent reduction in sulfur emissions. Coal is burned to produce combustion gases (seeded with materials having low ionization potentials) hot enough (around 5000°F) to have an electron concentration sufficient to make them electrically conducting. In the presence of a

magnetic field, they are forced at high velocity through a channel, and the current thereby induced is conducted by electrodes mounted in the sides of the gas duct. The hot exhaust gases are used to produce steam, which also generates electricity. MHD technology is still in developmental stages and will probably not have much effect on coal utilization until the end of this century.

## **COAL GASIFICATION**

Coal gasification is not new; many "modern" improvements were introduced before the turn of the century. In the mid-1920's there were 12,000 gas producers operating in the United States, but the advent of cheap natural gas as a fuel put them out of business. Coal gasification involves the reaction of hot coal and steam with oxygen or air to form gaseous hydrogen, carbon monoxide, and residual ash. Depending on use of oxygen or air, various other gases and byproducts are present in the raw gas produced and the Btu content varies accordingly. If air is used, the Btu content will be 100-250 Btu/ft<sup>3</sup> (low-Btu gas); if oxygen, the Btu content will be 200-500 Btu/ft<sup>3</sup> (medium-Btu gas). When air is used, the Btu content is lower, because atmospheric nitrogen contributes nothing useful to the reaction and dilutes the final product.

Medium-Btu gas produced by oxygen-blown systems can be methanated to raise the Btu gas content to 900-1000 Btu/ft<sup>3</sup> which would allow clean, high-Btu gas to be substituted for natural gas. Naturally, it costs more to produce high-Btu gas, and the process is more complex. The advantage of coal gasification is that the clean gas product can be used for a variety of purposes, such as fuel and as a raw material to produce ammonia, methanol, gasoline, and other synthetic hydrocarbon liquids. The disadvantages are its expense, complexity, and the need for a complicated gas-cleanup system to remove potential pollutants. However, the gas-cleanup system has an advantage over flue-gas desulfurization: it produces elemental sulfur rather than wet sludge.

Because it is applicable to thin multiple-seam coal beds, *in situ coal gasification* deserves consideration in Missouri. Coal is gasified through drillholes in the coal seam. Combustion is started and air injected through one or more drillholes. Steam is injected and combustible gases are tapped at other drillholes. The technique is applicable to thin multiple-seam coal beds ranging from 150 to 1000 feet below the surface. Commercial application is long term, but if technological and environmental problems can be solved, recoverable reserves in Missouri could be enlarged.

### COAL LIQUEFACTION

Several processes exist to convert coal indirectly (coal gasification) or directly to synthetic hydrocarbon liquids. Liquefaction was first tried in Germany in the early 1900's. Friedrich Bergius' direct-liquefaction techniques produced about 90 percent of Germany's aviation fuel during World War II; Franz Fischer's and Hans Tropsch's indirect process provided the remaining 10 percent. Coal-liquefaction techniques can produce a broad spectrum of products: synthetic crude oil, gasoline, petrochemical raw material, etc. Currently, the nation of South Africa has the only commercially operating coal-liquefaction plants. Since 1965, SASOL I has been producing about 10,000 barrels of hydrocarbon liquids daily, using the Fischer-Tropsch process. SASOL II and SASOL III are expected to be operational in 1983, producing 120,000 barrels daily. These three plants are expected to consume up to 75,000 tons of coal daily, which is more than the total daily consumption in Missouri. There is still much disagreement in the United States concerning which coal-liquefaction techniques should be emphasized. Both the direct and indirect processes have advantages and disadvantages. The direct processes are likely to be cheaper and less complex, but less is known about the environmental aspects and techniques in general. Indirect techniques are less efficient, but more is known about them and they could be brought on-line sooner. It is unlikely that this debate will be settled soon.

### COAL BENEFICIATION

Coal beneficiation involves decreasing deleterious factors, such as ash-forming materials and sulfur, and results in the upgrading of coal by increasing its Btu content. There are numerous coal beneficiation techniques. Coals can be washed in water or water-based media, using gravity methods, which rely on the differences in specific gravity between the coal and undesirable constituents. In the heavy-media process coal floats in a water-based medium of controlled specific gravity, permitting the heavier minerals to sink and be removed as rejects. The concentrating table separates coal from rejects by stratification induced by vibration. Cyclones supplement gravity by separating coal from impurities centrifugally. Froth flotation uses chemicals to form air bubbles, which selectively attach themselves to the coal but permit ash-forming materials to settle. Coal washing and beneficiation are currently used at some of the operating mines in Missouri. Preparation varies from simple washing and screening to remove coarse shale and pyrite, to beneficiation by jigging, tabling, and cyclone separation. Increased use of Missouri coals in either new or existing facilities will strongly depend on the ability of coal producers and coal consumers to meet sulfur-emission regulations; a decrease in sulfur content by coal beneficiation can help meet them.

The *Solvent-Refined Coal Process (SRC)* can provide a clean-burning low-sulfur fuel from high-sulfur coal. Technically, SRC is not classified as a coal-beneficiation process; however, it is appropriate to include it in this discussion of Missouri coal. In the SRC process sulfur and ash are removed from the coal, using a process-derived organic solvent. The SRC I process produces a solid fuel with a heating value of 16,000 Btu/lb., 0.1 percent ash, 2.0 percent nitrogen, and less than 0.8 percent sulfur. In SRC II, the process severity is increased, and the product changes to a liquid fuel containing 1.0 percent nitrogen, 0.2 percent to 0.3 percent sulfur, and having a heating value of 17,300 Btu/lb. Fuels made by these methods are suitable for boilers and peaking units.

## RECOMMENDED RESEARCH

Coal research has had relatively little serious encouragement in Missouri. Resource and reserve investigations have been carried out under low levels of state general-revenue financing and by modest, but important, federal support. A wider variety of research on coal and coal-related issues has been conducted at colleges and universities and in private research laboratories. In-house research by the coal industry is presumed not to be extensive, and the results of contracted studies are generally not available. State agencies and institutions should sponsor or encourage more research programs to enhance Missouri's coal industry. The Advisory Council recommends consideration be given to supporting research in five areas:

- I. Assessment of markets and transportation networks
- II. Assessment of resource base
- III. Assessment of financial and institutional barriers
- IV. Assessment of mining and land reclamation technology
- V. Assessment of utilization choices

### ASSESSMENT OF MARKETS AND TRANSPORTATION NETWORKS

Research programs in this category should concentrate on defining new and expanded markets for Missouri coal. Factors determining the choice of coal supply for new utility plants should be analyzed in detail so that all options can be defined. Special attention should be given to opportunities that may result from an expanded coal-export market. Marketing, technology, and planning symposia could be very useful to Missouri's small operators and ought to be developed. Long-range studies are needed of coal-supply requirements for coal synthetic fuels plants and their relationship to Missouri's coal-production capacity.

The near-term market for Missouri coal is largely limited to electric utilities. Approaches to expanding this market in Missouri and adjacent states should be evaluated.

In order to determine if transportation methods and costs are major detriments to expanding Missouri coal production and use, models should be developed to characterize the transportation network serving the Missouri coal industry. Rail-line abandonment, and inadequate road and bridge structures are particular problems.

### ASSESSMENT OF RESOURCE BASE

**RESOURCE ASSESSMENT:** The need for sound assessment of Missouri coal characteristics is underscored considering the competition for coal of various characteristics and from various geographic locations, that may accompany commercial synthetic-fuel production, and considering the degree to which the efficiency and economics of existing boilers and flue-gas cleanup equipment depend on coal characteristics. In addition, characterization of Missouri's current and prospective coal supplies will permit realistic examination of alternative emission-control planning for the future. Much has been done, but major work remains.

Assessment of Missouri's coal resources should include the following:

1. *Systematic Evaluation of Reserves*
  - a. Core drilling and sampling of coal seams, overburden, and intervening strata in Missouri coal fields
  - b. Geological and geophysical studies to define the limits of potential new fields in the Western Interior Basin in Missouri.
  - c. Updating the mapping of coal deposits in the state.
2. *Characterization of Coals in the Resource Base*
  - a. Establishment of a systematic sampling program and of a depository for representative samples for all coal seams in Missouri fields.
  - b. The petrographic and seam characteristics for all representative depository samples.

- c. Proximate and ultimate analysis, trace-element content, and ash-fusion temperature of all depository samples.
- d. Characterization of the enclosing rock for all samples in the depository as relates to mine design, production, strata control, and reclamation.
- e. Assessment of lateral variations in each coal seam in Missouri fields.
- f. Based on characteristics, classification of all seams for best ultimate use.
- g. *Coal Beneficiation*: The quality of Missouri coal can be upgraded by improved coal-preparation and beneficiation procedures. More attention to reduction of sulfur and ash content would result in a more desirable, more uniform product better suited to a variety of uses. Research in this area should include the following:
  - 1. Washability studies of representative depository samples to determine possibility of removing pyritic sulfur and ash by conventional coal-preparation techniques.
  - 2. Conduct studies of alternate coal-preparation techniques: heavy media, high-gradient magnetic separation, etc., for beneficiating depository samples.
  - 3. Assessment of amount and nature of organic sulfur in depository samples and investigate techniques for sulfur removal by modifications to, or processing subsequent to, coal preparation.

## ASSESSMENT OF FINANCIAL AND INSTITUTIONAL BARRIERS

Various financial and institutional issues may hinder expansion of Missouri's coal industry. The current problems with reclamation bonding are an example — one that apparently will be resolved through public and private cooperation and enterprise. State agencies should be encouraged to review all regulations in order to improve their implementation and to remove

thereby unnecessary barriers to expansion of Missouri's coal industry. The effect of fuel-adjustment clauses negotiated as part of utility rate agreements should also be evaluated. Legislative and regulatory changes supporting increased coal development and utilization require constant review and study.

## ASSESSMENT OF MINING AND LAND RECLAMATION TECHNOLOGY

Coal-mining technology should be reviewed to identify the techniques which are economical and environmentally sound and also enhance the marketability of Missouri coal. Specific research topics are the following:

### A. *Coal Production*:

- 1. Assessment of economic, environmental, and reclamation consequences of multiple-seam mining in all coal fields with two or more workable seams.
- 2. Assessment of feasibility of *in situ* liquefaction or gasification of deep, thin seams.
- 3. Assessment of feasibility of recovering coal from deep, thin seams by oscillating, "round-the-corner," high-pressure water-jet cutting.
- 4. Assessment of economic, environmental, and reclamation benefits of alternate mining methods and equipment in surface mining.

### B. *Environmental and Land Reclamation*:

- 1. Assessment of the potential for surface- and subsurface-water contamination in mining Missouri coal.
- 2. Establishment of baseline data against which to assess reclamation effectiveness.
- 3. Assessment of alternatives to land reclamation in order to minimize erosion while carrying out surface drainage of reclaimed areas.
- 4. Assessment of alternative methods for replacing topsoil, which avoid excessive compaction.
- 5. Assessment of the effect of mixing soil horizons, on their ultimate fertility and adaptability as topsoil.



## ASSESSMENT OF UTILIZATION CHOICES

Increased use of relatively high-sulfur Missouri coal would increase concern about a number of environmental issues related to air quality, particularly SO<sub>2</sub> emissions. Increased coal use may exacerbate the difficulty of meeting State Implementation Plans, of meeting the PSD requirements while still permitting growth, of finding sufficient offset in nonattainment areas, and of finding economically efficient ways of controlling emissions from small boilers. Furthermore, there is an emerging awareness of acid-rain/acid pollution as a potential problem, and of the fact that variations in sulfur content, and temporal variations in the efficiency of flue-gas scrubbers are important in determining if fuel sources will exceed air-quality standards.

Utilization research should concentrate on identifying of use options that can mitigate environmental problems associated with increased use of Missouri coal. Specific research topics should include the following:

### 1. *Direct Utilization:*

- a. Assessment of problems associated with the environmentally acceptable

burning of Missouri coal in existing coal-fired boilers or retrofitted oil- or gas-fired boilers — assuming the most efficient levels of coal beneficiation.

- b. Assessment of problems associated with environmentally acceptable coal-to-electricity processes, i.e., the fluidized-bed boilers, combined power cycles, magnetohydrodynamics, etc.

### 2. *Indirect Utilization:*

- a. Based on characteristics of coal by seam and field, assessment of the potential reserves of Missouri coal most suitable for gasification by current technology.
- b. Research and development concerning new coal-gasification techniques that may be more effective in treating Missouri coal.
- c. Based upon characteristics of coal by seam and field, assessment of the potential reserves of Missouri coal for processing by pyrolysis to produce synthetic hydrocarbon liquids.
- d. Based upon their characteristics, assessment of Missouri coals that may be processed by direct-liquefaction techniques.

## POLICY OPTIONS (Conclusions and Recommendations)

The Advisory Council on Missouri coal identifies the following current and long-range issues for attention at state government level, and suggests the options that should be considered, recognizing that as conditions change, policies will require review and possibly revision.

1. Missouri state government should be strongly committed to development of Missouri coal resources. Based on current recoverable-reserve data, the state coal resource base is adequate to support production levels substantially above current rates until about 2010.

Missouri coal is suitable for many older electric utility plants and can be used in new facilities with appropriate flue-gas desulfurization equipment. It is also suitable as raw material for many synthetic-fuel processes. Missouri's coal should be seen as an important asset to the state as we anticipate increasing national reliance on coal as a primary energy source.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends that *State Government* adopt a strong commitment to the

*development and utilization of the state's coal resources.* Executive-level commitment is essential to such a policy for a number of reasons, including 1) the increasing interaction between state and federal government in energy-resource development and the need for executive support of appropriate actions, including funding requests, and 2) the many opportunities for executive action in encouraging local and regional resource development. We believe that a strong commitment to development and utilization of Missouri coal will have the following effects: 1) Expansion of the coal-mining industry in Missouri. 2) Increased employment in coal-mining and related industries. 3) Assurance of a continued coal supply for Missouri's utilities and industries.

- II. Utilities are the largest current and near-term market for Missouri coal. Many electric utility plants in the state could use Missouri coal but do not for reasons peculiar to the utilities industry and to marketing/purchasing practices. In many instances, it might appear that using Missouri coal would save transportation and perhaps other costs, but these would be offset by higher land reclamation costs on a per-ton basis and by varying coal quality.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends that *State Government adopt as a goal, the use of Missouri coal in utilities plants*, naturally recognizing that utilities will choose the most reliable and economical sources. Continuing emphasis on promoting the use of Missouri coal will be necessary at all levels of state government. State regulatory, resource, legislative, and administrative offices and bodies can provide support strengths peculiar to

each. Increased use of Missouri coal in Missouri utilities can deter further erosion of the industry's market in the state and can help maintain a viable coal industry in Missouri: the decision by Associated Electric Cooperative, Inc., to use Missouri coal in its expanded Thomas Hill plant was important to Missouri coal development. Municipal Power Pooling for new generation and transmission facilities may help increase the market for utility coal; therefore, liaison with the Missouri Joint Municipal Electric Utility Commission is important.

- III. Using coal as an industrial fuel represents both an expanding market for Missouri coal and a potentially less expensive fuel. Although converting to coal may not be economically attractive in individual cases, the replacement of old and construction of new coal-fired industrial boilers should be encouraged. Facilities using natural gas as a raw material or process fuel should consider small coal-gasification plants as an adjunct to their operation, possibly with a sharing agreement with one or more other industries. Increased use of coal by industry would particularly benefit Missouri's small coal operators.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends that *State Government should more strongly encourage use of Missouri coal in industrial plants* to help ensure the most economical and reliable fuel supplies. Regulatory agencies can support this recommendation by developing efficient permitting procedures, as required.

- IV. The use of Missouri coal in state institutions has been a statutory requirement for many years but has had little effect because of the language of the

statute. New approaches to this matter were incorporated in HB 637 and SB 342, 81st General Assembly. The importance of this legislation is mainly its articulation of the commitment of state government and its potential to demonstrate the practical application of new coal technology such as fluidized-bed combustion, in institutional and industrial boilers.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends that *State Government initiate and support appropriate legislation concerning use of Missouri coal in state institutions*. In the interim, it may be appropriate for the Governor to direct that some parts of the legislative proposals be adopted as a matter of policy.

- V. Environmental regulations continue to be identified at state and national levels as major deterrents to increased coal development and utilization, although all concerned admit the need for environmental protection. Air-quality and land-reclamation regulations are the principal environmental controls affecting the coal industry in Missouri. Water quality is a factor less apparent to the public, but it receives attention in land-reclamation regulation, through cooperation with State Water Pollution Control staff and State Solid Waste Control Programs. Air-quality, land-reclamation, and water-quality regulations affect the mining and utilization of coal 1) during mining operations and coal preparation, 2) during transportation, 3) during stockpile or storage operations, and 4) during utilization (currently nearly all in steam power plants). Gasification, liquefaction, or other processing will involve the same regulatory concerns,

but with varying emphasis in certain areas, e.g., air quality.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends that *State Government propose State and Federal reassessment and analysis of state regulatory programs affecting development and utilization of coal in Missouri*. Many aspects of environmental regulations, including the Clean Air Act and Office of Surface Mining Regulations, are presently under federal review or are so scheduled. Missouri's position on these matters should be heard.

There is certain to be increased emphasis on coal-based synthetic-fuel development in the United States. Missouri's coal and water resources are able to support such development, and there have been numerous proposals concerning this during the past 5 to 10 years. Many potential uses for synthetic-fuel products and byproducts have been identified; a major proposal involving two large separate installations continues to show promise.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends *strong, clearly defined support for coal gasification and other coal-based synthetic-fuel projects, where thorough technical analysis demonstrates their validity and suitability*. Coal-gasification and other synthetic-fuel plants could convert Missouri coal to clean-burning, low-sulfur fuels. Consumer Energy Corporation's plans for gasification plants at Reger and Yates are well advanced, and continued support should be given this project, which would consume substantial tonnages of northern Missouri coal for several decades.

VII. Although there is a tendency to believe that research needs supporting Missouri coal development are being met through national programs, there are clearly specific areas in which research and reporting would have direct effect at the state level. They include the following:

1. Coal preparation and beneficiation studies are needed to show the most practical and economical means of upgrading the quality of Missouri coal for market. Missouri coal is roughly of the same quality as that of the other states in the Interior Coal Region. Ash and sulfur content can be reduced and Btu value increased by improved washing and other beneficiation techniques. High-quality coal will be important in a competitive market.
2. Studies are needed to show how Missouri coal can be used in environmentally acceptable ways in the next generation of coal-to-steam and coal-to-electricity systems, e.g., fluidized-bed boilers and combined power cycles.
3. Studies are needed to demonstrate the most effective coal-gasification and coal-liquefaction techniques for Missouri coal.
4. Definitive studies are needed to demonstrate more efficient surface-mining methods for thin coal seams and to address regional problems concerning prime-farmland reclamation. Such studies would benefit current and new coal operators and would help state land-reclamation officials allow coal mining and concurrent land-reclamation work to proceed as cheaply as possible for operators.
5. Market studies of Missouri coal are currently carried out by coal producers

and consumers, but it is necessary to coordinate efforts to export coal and to identify and assist in meeting the needs of new state markets.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends that *State Government support needed research that would directly affect development and utilization of Missouri coal.* The Council suggests that state agencies, particularly the Missouri Division of Community and Industrial Development (CID), be directed to cooperate with coal producers by assisting in developing market survey and analysis techniques.

VIII. Public financing or quasi-public financing of energy-related projects has been tried by many states and the federal government. The Governor's Advisory Council on Missouri Coal has examined the issue of public financing and assistance in this area and finds most of the problems are legal and institutional. The Missouri Constitution prohibits use of state money to benefit a private entity directly, e.g., direct grants of money to private firms. Both federal and Missouri laws allow the state to assist in securing private money for private projects. The Environmental Improvement Authority designates pollution-control projects that qualify for tax-free bond financing. In this way the interest rate that a private entity pays is lowered because of the tax-exempt status of the issue, and because the lender pays no taxes on the interest he receives. In the current session of the legislature, one bill would extend the Environmental Improvement Authority's function to include energy projects. The problem that arises, however, is that the issue of tax-exempt bonds or notes is regulated by the federal Internal Revenue Code. At present there is a \$1-million



limitation on issues that are not specifically exempted, such as pollution-control measures.

**Recommendation:** The Governor's Advisory Council on Missouri Coal recommends *further investigation to identify existing measures that could be used by state or local governments to assist private industry in developing facilities that could utilize Missouri coal,*

and that when those measures are identified, possible changes in state or federal law be sought to make the most effective use of them. The Council believes much could be done in the area of revenue bonding, loan guarantees, and similar methods without exposing the taxpayer to increasing expenses or to unreasonable risks.

## Appendix I

### MEMORANDA/RECOMMENDATIONS TO GOVERNOR TEASDALE (1980) AND GOVERNOR BOND (1981)

#### Governor's Advisory Council on Missouri Coal

1. (March 6, 1980) Preliminary memorandum on Tebo Mine closing, summarizing Council representation meeting with local interests at Clinton, Missouri, on March 4, 1980.
2. (April 7, 1980) Advisory Council's comment on suspension of operations at the Tebo Mine in Henry County. Provides objective assessment of issues, as developed since mine closing in late December 1979.
3. (April 8, 1980) Resolution commending Governor Teasdale's interest and support of the coal gasification efforts of Consumer Energy Corporation, with strong recommendation that he support their current efforts to secure \$4 million in DOE funds for feasibility study.
4. (May 23, 1980) Resolution relating to S 1403 (Jackson) recommending that Missouri support "states-rights" approach. Letter included background information.
5. (August 14, 1980) Recommendations concerning FY 82 appropriations and suggested legislation, for introduction in the 1st Session, 81st General Assembly, Missouri Legislature. Included memorandum on *Current Issues of National Scope and Concern*. Memorandum describing then-current status of HR 6625, HR 6654, and S 2695, relating to establishment of a 12.5 percent ceiling on severance taxes levied on coal production, noting effect on Missouri's coal industry and utility customers.
6. (August 27, 1980) Amended listing of recommendations with regard to FY 82 appropriations and suggested legislation. A number of these recommendations were incorporated in legislative and "budget" proposals for FY 82.
7. (Sept. 4, 1980) Proposed Coal Gasification Facility in Henry County, Missouri. Advisory memorandum for Governor's office, pending formal response by Advisory Council.
8. (Sept. 29, 1980) Status of Land Reclamation Law and Regulations in Missouri. An advisory memorandum describing the current status of state program development, with notations regarding 1) Missouri Land Reclamation Commission's *resolution* on stringency of state compared to federal regulations, 2) then-current status of S 1403, and 3) potential for application of Section 503(d) of PL 95-87 in Missouri. A copy of the LRC Resolution and an Assistant Attorney General's comment on that resolution were included as supplemental information.
9. (Oct. 21, 1980) Memorandum urging Governor Teasdale to support the Consumer Energy Corporation/Associated Electric joint venture for coal gasification projects in northern Missouri.
10. (Nov. 6, 1980) Informational copy of Council's response and recommendations to Mr. Peter Clearwater, Clinton, regarding his preliminary proposal for a coal gasification facility in Henry County.
11. (Dec. 12, 1980) Memorandum recommending that Governor Teasdale retain the present Advisory Council for one year, with the expectation that in-coming Governor Bond would modify the composition of the Council, beginning January 1982, and would also indicate major change(s) in Council direction and emphasis if appropriate.

Appendix I (continued)

12. (Jan. 26, 1981) Transmitted Council Profile containing then-current information on Council organization, function, membership, and authority, for incoming Governor Bond's personal and administrative reference. (See attached)
13. (Feb. 19, 1981) Memorandum to Governor Bond outlining problems faced by coal operators concerning reclamation bonding requirements, with recommendation that HB 116 be supported and signed as an emergency measure; that the Mined Land Reclamation Commission and Program staff expedite efforts to develop alternatives to the bonding requirements; and that his administration explore efforts concerning the extension of the interior regulatory program at both the state and federal levels.
14. (Feb. 20, 1981) Memorandum through Fred Lafser to Governor Bond urging that the mined-land reclamation bonding problem in Missouri be brought to the attention of DOI Secretary Watt during the Governor and Mr. Lafser's meetings with Secretary Watt during the National Governor's Association Meeting in Washington.
15. (Feb. 24, 1981) Memorandum to DNR Director recommending that Missouri seek formal affiliation with the Interstate Coal Task Force, with supplemental material concerning function of the Task Force and suggested procedure. With Governor Bond's approval, Director Fred A. Lafser was able to expedite the Council's recommendation by direct contact with the ICIF Chairman.

## Appendix II

REMAINING IDENTIFIED RECOVERABLE COAL RESERVES OF MISSOURI AS OF JULY 31, 1976  
(MILLION SHORT TONS)

County	Strippable Reserves				Subsurface Reserves				Total Reserves			
	Measured	Indicated	Inferred	Total	Measured	Indicated	Inferred	Total	Measured	Indicated	Inferred	Total
Adair	6.0	33.2	11.5	50.7	31.8	98.9	118.0	248.7	37.8	132.1	129.5	299.4
Andrew	---	---	---	---	---	---	---	---	---	---	---	---
Atchison	---	---	---	---	---	---	---	---	---	---	---	---
Audrain	13.5	42.2	23.7	79.4	1.9	54.2	3.5	59.6	15.4	96.4	27.2	139.0
Barton	39.5	80.3	36.1	155.9	---	---	---	---	39.5	80.3	36.1	155.9
Bates	63.4	55.3	0.2	118.9	42.2	76.7	52.9	171.8	105.6	132.0	53.1	290.7
Boone	57.2	93.4	6.9	157.5	14.1	13.4	4.9	32.4	71.3	106.8	11.8	189.9
Buchanan	---	---	---	---	---	---	---	---	---	---	---	---
Caldwell	---	---	---	---	---	---	64.3	64.3	---	---	64.3	64.3
Callaway	20.0	28.6	7.5	56.1	8.9	37.9	13.8	60.6	28.9	66.5	21.3	116.7
Carroll	---	---	1.4	1.4	---	---	---	---	---	---	1.4	1.4
Cass	---	---	---	---	1.2	18.8	16.4	36.4	1.2	18.8	16.4	36.4
Cedar	7.1	17.2	0.7	25.0	---	---	---	---	7.1	17.2	0.7	25.0
Chariton	12.4	8.3	0.3	21.0	19.7	6.7	64.5	90.9	32.1	15.0	64.8	111.9
Clark	---	---	---	---	---	---	---	---	---	---	---	---
Clay	---	---	---	---	---	---	16.2	16.2	---	---	16.2	16.2
Clinton	---	---	---	---	---	---	44.3	44.3	---	---	44.3	44.3
Cooper	0.1	0.4	---	0.5	---	---	---	---	0.1	0.4	---	0.5
Dade	1.0	0.4	---	1.4	0.3	2.4	---	2.7	1.3	2.8	---	4.1
Daviess	---	---	---	---	1.2	3.5	32.4	37.1	1.2	3.5	32.4	37.1
Dekalb	---	---	---	---	---	---	---	---	---	---	---	---
Gentry	---	---	---	---	---	---	---	---	---	---	---	---
Grundy	---	---	---	---	1.4	2.6	11.6	15.6	1.4	2.6	11.6	15.6
Harrison	---	---	---	---	8.8	74.7	108.5	192.0	8.8	74.7	108.5	192.0

From: Robertson, Charles E., and Smith, David C. (in press) Coal Resources and Reserves of Missouri: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations 66, p. 18-19.

County	Strippable Reserves				Subsurface Reserves				Total Reserves			
	Measured	Indicated	Inferred	Total	Measured	Indicated	Inferred	Total	Measured	Indicated	Inferred	Total
Henry	112.6	130.5	46.6	289.7	16.7	41.8	101.7	160.2	129.3	172.3	148.3	449.9
Holt	---	---	---	---	---	---	---	---	---	---	---	---
Howard	12.1	54.0	16.1	82.2	1.5	11.9	7.0	20.4	13.6	65.9	23.1	102.6
Jackson	---	---	---	---	---	---	---	---	---	---	---	---
Jasper	1.6	9.4	10.8	21.8	---	---	---	---	1.6	9.4	10.8	21.8
Johnson	28.7	26.8	52.0	107.5	3.8	10.1	30.0	43.9	32.5	36.9	82.0	151.4
Lafayette	7.7	31.5	33.5	72.7	3.4	6.9	---	10.3	11.1	38.4	33.5	83.0
Lewis	---	---	---	---	---	---	---	---	---	---	---	---
Linn	---	---	---	---	11.5	23.1	247.7	282.3	11.5	23.1	247.7	282.3
Livingston	0.5	0.5	---	1.0	---	---	---	---	0.5	0.5	---	1.0
Macon	53.4	48.2	---	101.6	9.5	18.0	166.1	193.6	62.9	66.2	166.1	295.2
Mercer	---	---	---	---	20.6	134.1	122.9	277.6	20.6	134.1	122.9	277.6
Monroe	3.4	24.4	41.0	68.8	---	---	---	---	3.4	24.4	41.0	68.8
Montgomery	1.0	9.4	13.6	24.0	---	---	---	---	1.0	9.4	13.6	24.0
Nodaway	---	---	---	---	---	---	8.6	8.6	---	---	8.6	8.6
Pettis	0.4	1.2	2.4	4.0	---	---	---	---	0.4	1.2	2.4	4.0
Platte	---	---	---	---	---	---	---	---	---	---	---	---
Putnam	31.5	88.4	11.8	131.7	7.0	57.0	75.7	139.7	38.5	145.4	87.5	271.4
Ralls	1.4	13.3	15.7	30.4	---	---	---	---	1.4	13.3	15.7	30.4
Randolph	91.0	220.9	25.5	337.4	22.4	110.2	4.7	137.3	113.4	331.1	30.2	474.7
Ray	---	---	---	---	9.5	22.2	31.7	63.4	9.5	22.2	31.7	63.4
St. Clair	14.7	3.7	---	18.4	---	---	---	---	14.7	3.7	---	18.4
Saline	---	---	---	---	---	---	---	---	---	---	---	---
Schuyler	---	---	---	---	0.2	0.5	1.0	1.7	0.2	0.5	1.0	1.7
Scotland	---	---	---	---	---	---	---	---	---	---	---	---
Sullivan	2.4	14.7	6.5	23.6	3.0	26.3	308.3	337.6	5.4	41.0	314.8	361.2
Vernon	50.5	122.0	70.8	243.3	1.2	1.7	---	2.9	51.7	123.7	70.8	246.2
Worth	---	---	---	---	0.2	0.7	8.8	9.7	0.2	0.7	8.8	9.7
<b>State Totals</b>	<b>633.1</b>	<b>1158.2</b>	<b>434.6</b>	<b>2225.9</b>	<b>242.0</b>	<b>854.3</b>	<b>1665.5</b>	<b>2761.8</b>	<b>875.1</b>	<b>2012.5</b>	<b>2100.1</b>	<b>4987.7</b>